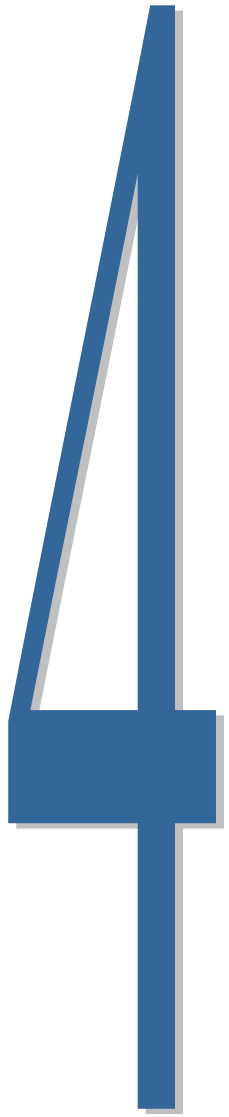


3D 控件的开发



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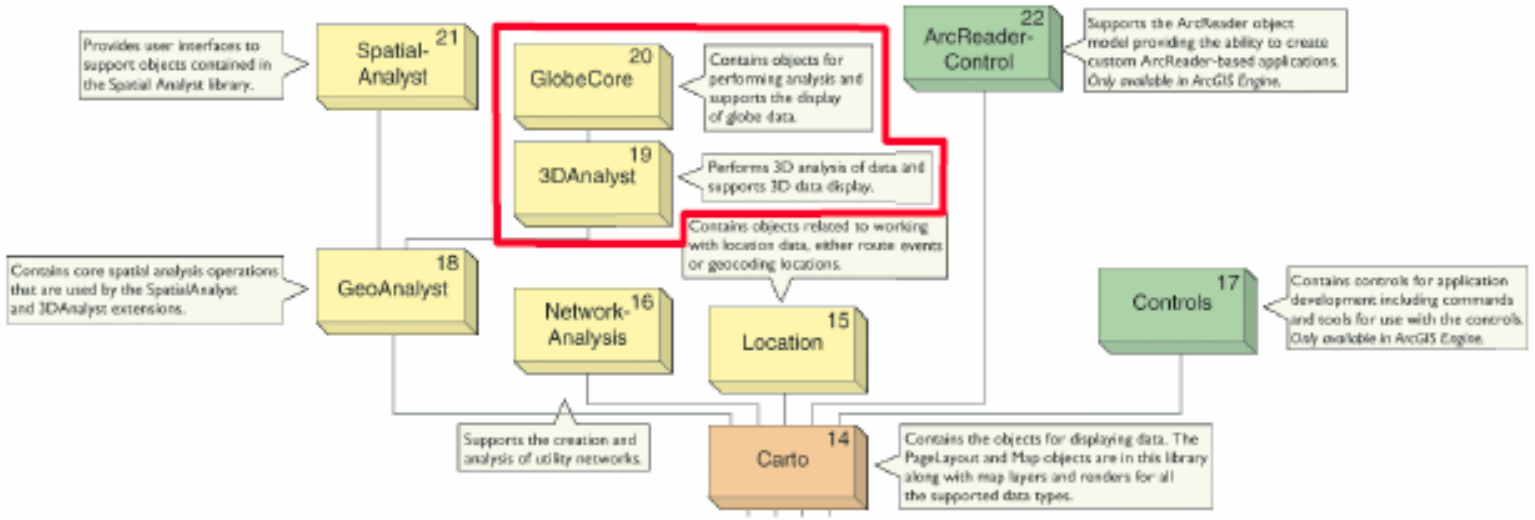
课 4 概述

- **ArcGIS Engine 3D 库和控件**
- **3D 控件**
- 命令和工具
- **3D 文档和数据源**
- 相关**3D**对象
- 关键方法和属性

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ArcGIS Engine 3D libraries

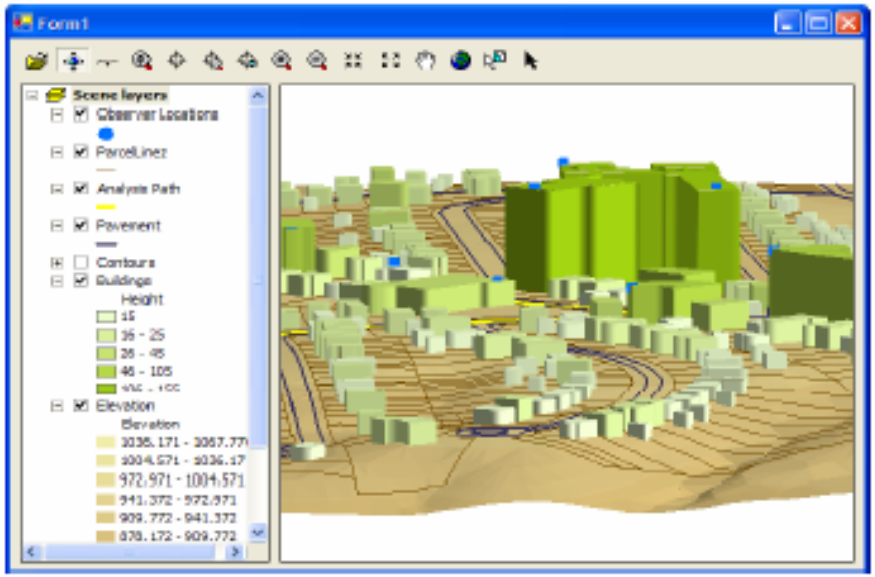
- **3DAnalyst (esri3DAnalyst.olb)**
  - SceneControl, Scene, SceneGraph, 3DProperties, SceneExporter3D, SceneViewer, 3DSymbol, AnimationTrack, …
- **GlobeCore (esriGlobeCore.olb)**
  - GlobeControl, Globe, GlobeDisplay, GlobeCamera, GlobeViewer, GlobeLayerProperties, GlobeLayer, AnimationTrack, …



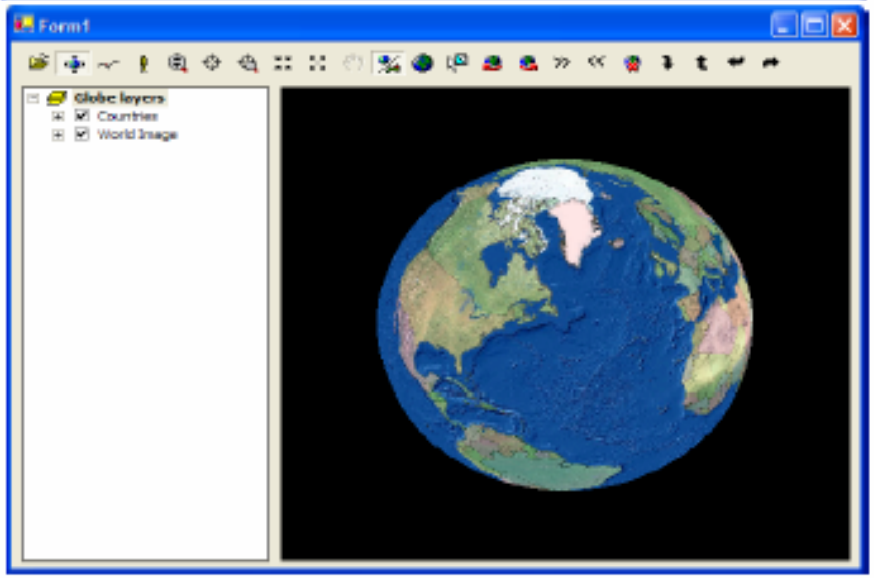
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Getting started with the 3D controls

- SceneControl
  - Corresponds to the 3D view of ArcScene



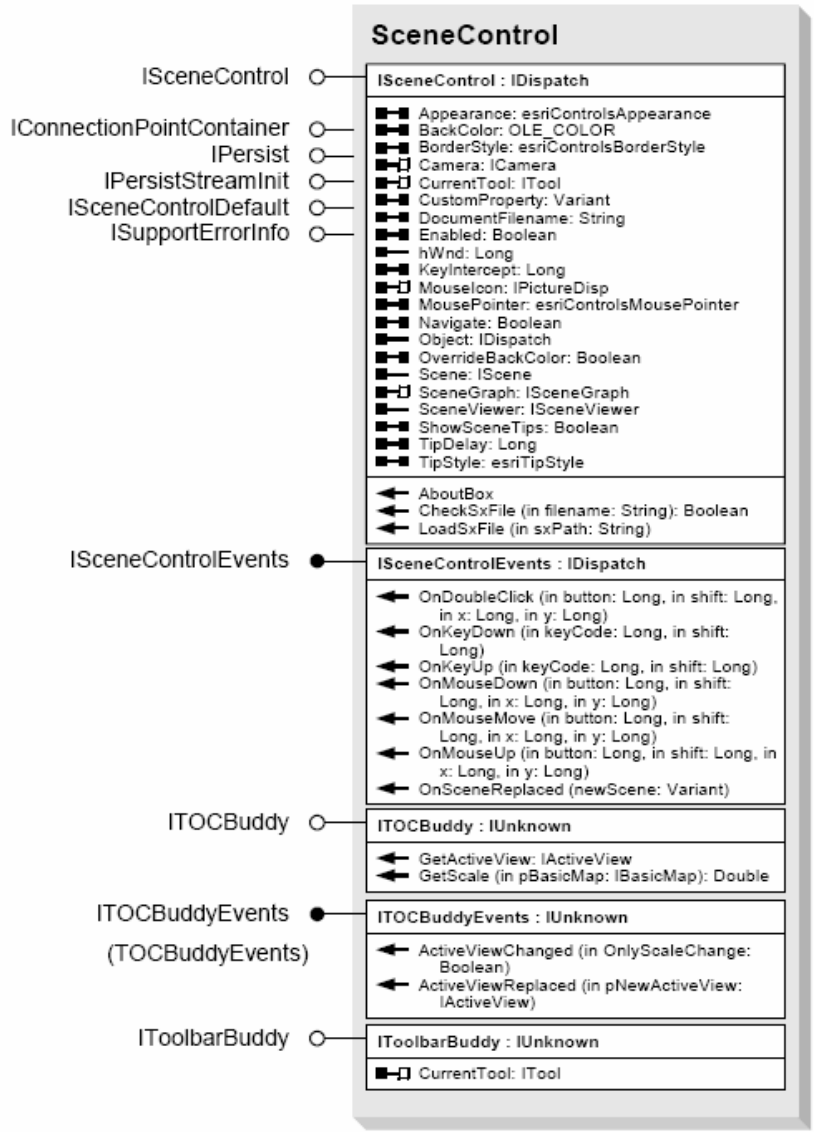
- GlobeControl
  - Corresponds to the 3D view of ArcGlobe



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Scene 控件

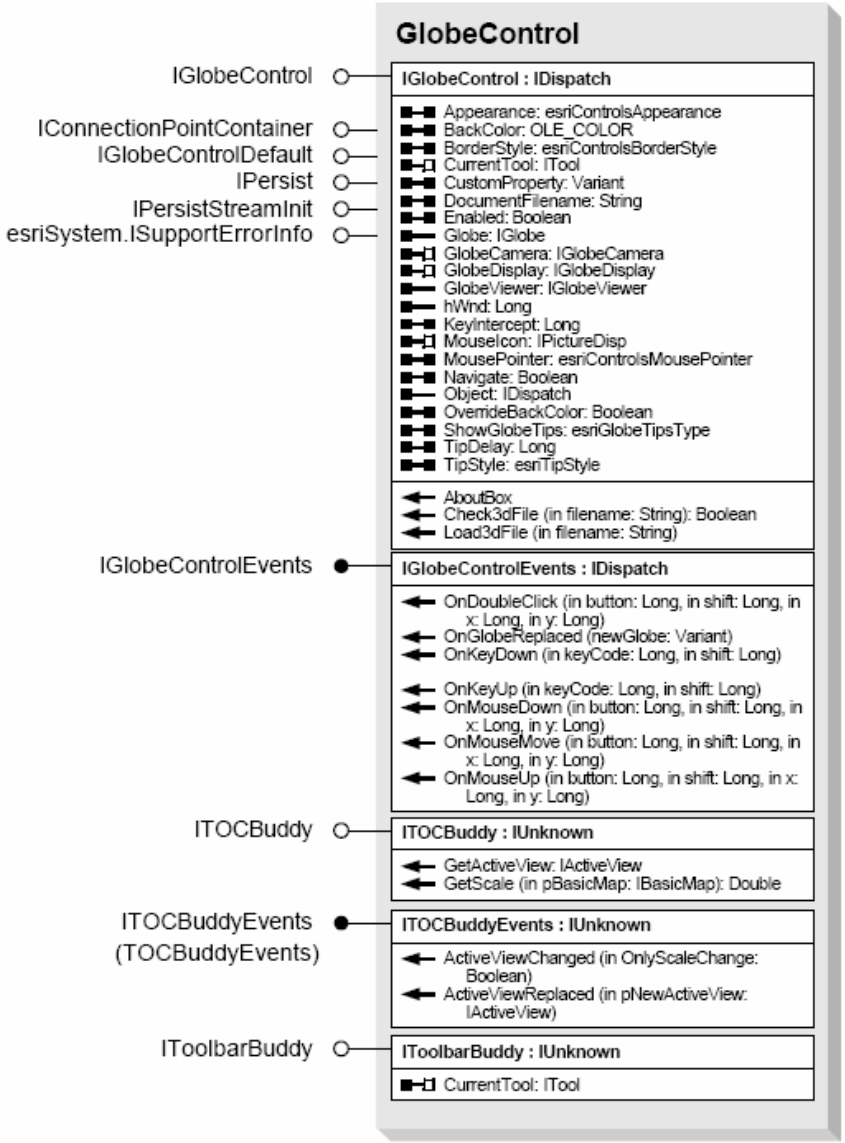
- SceneControl
  - 封装了 SceneViewer 类
  - 管理
    - General appearance
    - Scene
    - Scene graph
    - Camera properties
  - 设置当前工具
  - 加载 scene 文档
- 库
  - SceneControl.ocx



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Globe 控件

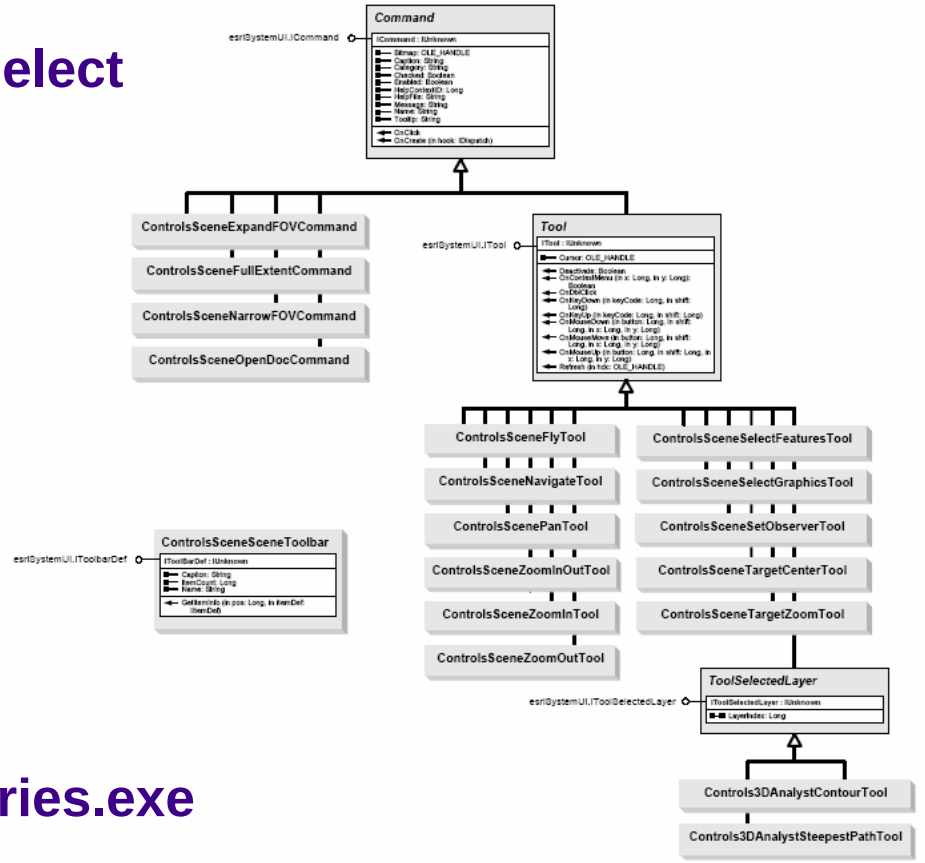
- GlobeControl
  - 封装了GlobeViewer 类
  - 管理
    - General appearance
    - Globe
    - Globe display
    - Globe camera properties
  - 设置当前工具
  - 加载 globe 文档
- 库
  - GlobeControl.ocx



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SceneControl 控件命令

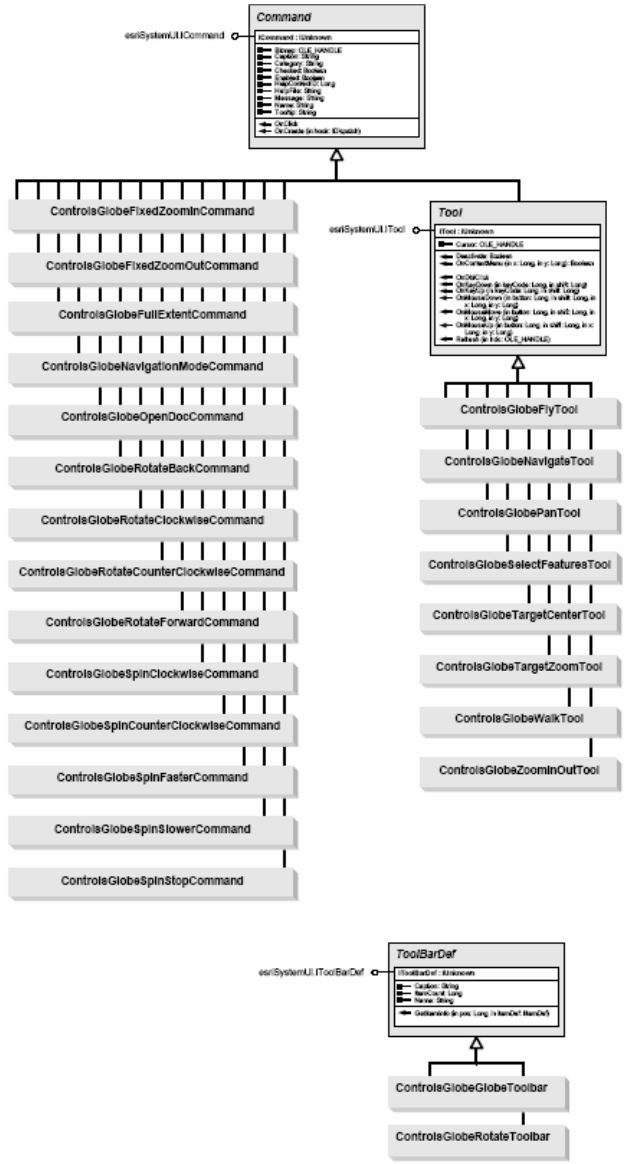
- 命令和工具
  - **Pan, zoom, fly, set observer, select**
- 工具条
  - **ControlsSceneSceneToolbar**
- 库
  - **esriSceneControl.ocx**
  - **esri3DAnalyst.olb**
- 参考
  - 对象模型图, 技术文档或 **Categories.exe**



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GlobeControl控件命令

- 命令和工具
  - **Pan, zoom, fly, target, select**
- 工具条
  - **ControlsGlobeGlobeToolbar**
  - **ControlsGlobeRotateToolbar**
- 库
  - **esriGlobeControl.ocx**
  - **esriGlobeCore.olb**
- 参考
  - 对象模型图, 技术文档或 **Categories.exe**



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增加 3D 控件项目到工具条

```
Private Sub TabControl1_Click(ByVal sender As Object, ByVal e As
   System.EventArgs) Handles TabControl1.Click
   If TabControl1.SelectedTab Is tbpgSceneCtrl Then
   'Scene
         …
   ElseIf TabControl1.SelectedTab Is tbpgGlobeCtrl Then
   'Globe
         AxToolbarControl1.SetBuddyControl(AxGlobeControl1)
         AxToolbarControl1.RemoveAll()
         Functions.AddGlobeCommands(AxToolbarControl1)
         AxTOCControl1.SetBuddyControl(AxGlobeControl1)
         Functions.SetCurrentTool(AxToolbarControl1, 1)
   End If
End Sub

Public Shared Sub AddGlobeCommands(ByRef toolBarControl As AxToolbarControl)
   toolBarControl.AddItem("esriGlobeCore.ControlsGlobeOpenDocCommand", , -1,
   False, , esriCommandStyles.esriCommandStyleIconOnly)
   toolBarControl.AddItem("esriGlobeCore.ControlsGlobeGlobeToolbar", , -1, True,
   , esriCommandStyles.esriCommandStyleIconOnly)
   toolBarControl.AddItem("esriGlobeCore.ControlsGlobeRotateToolbar", , -1,
   True, , esriCommandStyles.esriCommandStyleIconOnly)
End Sub
```

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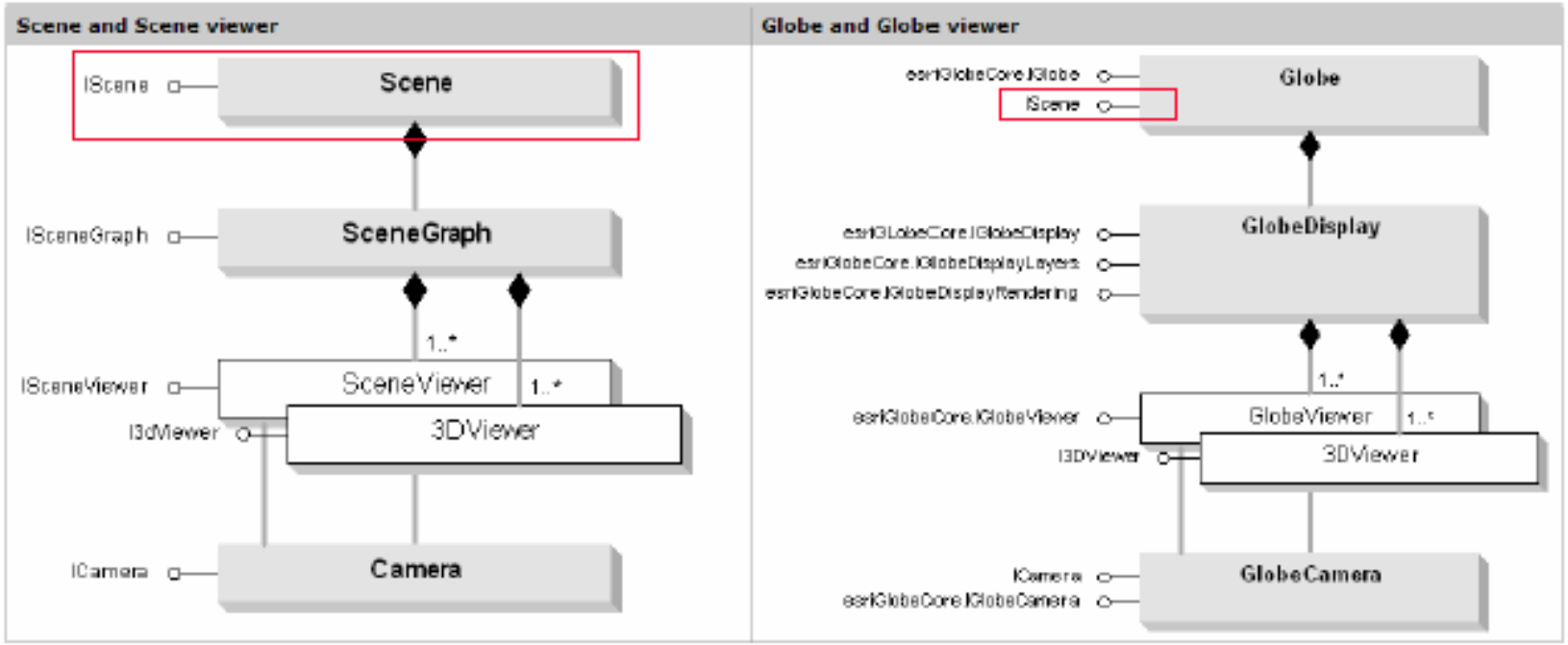
scene 和 globe的功能区别

Scene	Globe
- 3D 线符号 - tin 图层 - 立体和正面视图 - 最陡路径工具, 等高线工具 - 数据无需投影 - 图层动画 (位置变换) - 输出到vrml - 动态山影图 - 图层优先 - ‘场景’ 动画 - 3D 标记符号缩放比例控制	- 数据分页, LODs, 大容量数据处理 - 地理坐标系统 - 纹理图层绘制顺序控制 - 热链接 - 测量和 行走工具 - 导航工具: 放大/缩小,定位视图中心,缩放到目标 - 为栅格化矢量数据设置地图符号 - 旋转工具条 - 平视显示器（HUD） - near/far clip plane control on UI - 默认图层 - MapServer Layers - ArcIMS Image layers - 要素注记图层 - 导航工具的动画选项 - MOLE - 通过要素属性控制要素透明度

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Similar objects in Scene and Globe

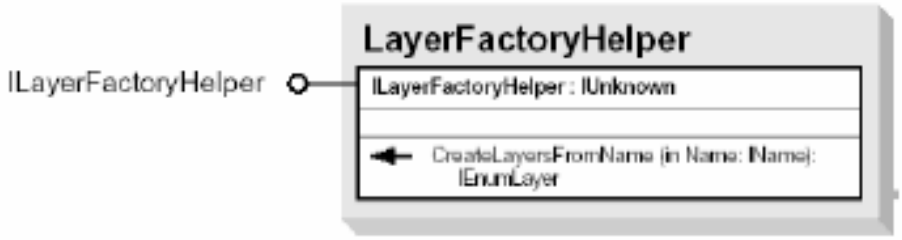
- ISceneControl/IGlobeControl
  - Scene/Globe
  - SceneGraph/GlobeDisplay
  - SceneViewer/GlobeViewer
  - Camera/GlobeCamera

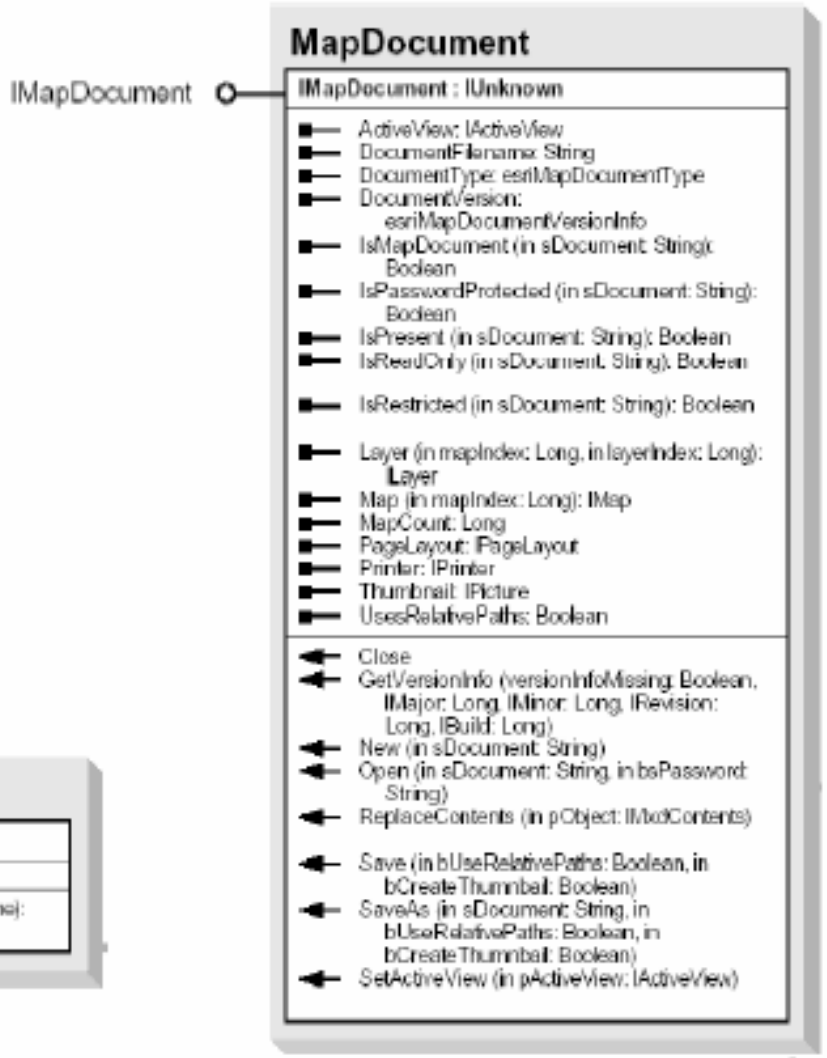


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3D controls: Accessing data

- Different approaches
  - Load 3D documents
  - Access a MapDocument
  - Use a LayerFactoryHelper
- Same for Scene and Globe





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加载 3D 文档

- ISceneControl/IGlobeControl
  - CheckSxFile/Check3DFile
  - LoadSxFile/Load3DFile
  - ShowSceneTips/ShowGlobeTips
  - TipStyle
  - TipDelay

```
Private Sub Form1_Load(…) Handles MyBase.Load
    Dim fileName As String = "C:\Program Files\ArcGIS\ArcGlobeData\Default_Document.3dd"
    If AxGlobeControl1.Check3dFile(fileName) Then
        AxGlobeControl1.Load3dFile(fileName)
        AxGlobeControl1.TipDelay = 500
        AxGlobeControl1.TipStyle = esriTipStyle.esriTipStyleTransparent
        AxGlobeControl1.ShowGlobeTips = esriGlobeTipsType.esriGlobeTipsTypeLatLon
    End If
End Sub
```

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访问 MapDocument

- 从 **mxd, lyr, pmf**文件访问图层
- 使用 **ObjectCopy** 或 **IBasicMap**

```
Dim mapDocument As IMapDocument = New MapDocument
If (Not mapDocument.IsMapDocument(sFilePath)) Then Exit Sub

mapDocument.Open(sFilePath)
Dim objCopy As IObjectCopy = New ObjectCopy
Dim map As IMap
map = objCopy.Copy(mapDocument.Map(0))

Dim scene As IScene
If TabControl1.SelectedTab Is tbpgSceneCtrl Then
   'Scene
   scene = AxSceneControl1.Scene
   scene.ClearLayers()
   scene.AddLayers(map.Layers, False)
ElseIf TabControl1.SelectedTab Is tbpgGlobeCtrl Then
   'Globe
   scene = AxGlobeControl1.GlobeDisplay.Scene
   scene.ClearLayers()
   scene.AddLayers(map.Layers, False)
End If
```

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通过 LayerFactoryHelper访问数据

- 加载任何实现了**IName**的对象

  例子: **FileName - lyr, tif, jpg, shp, …**

```
Dim file, files() As String
Dim pFileName As IFileName
Dim pLayerFactoryHelper As ILayerFactoryHelper
Dim pEnumLayer As IEnumLayer
Dim pLayer As ILayer
'Open a file dialog to add data
…
files = OpenFileDialog1.FileNames
For Each file In files
    pFileName = New FileName
    pFileName.Path = file
    pLayerFactoryHelper = New LayerFactoryHelper
    Try
        'Get the IEnumLayer interface through the ILayerFactoryHelper interface
        pEnumLayer = pLayerFactoryHelper.CreateLayersFromName(pFileName)
        pEnumLayer.Reset()
        pLayer = pEnumLayer.Next
        m_scene.AddLayer(pLayer)
    Catch ex As Exception
        MsgBox(file + " is not a valid layer and won't be added to the SceneControl")
    End Try
Next
```

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Globe支持的数据源

- 与**Scene** 和 **Map**不同, 所有的数据源必须定义了空间参考
- 空间参考可以是任何一种地理的或投影的坐标系统
- 在 **Globe 9.0,** 有些数据源是不被支持的
  - 跟踪分析图层
  - 测量图层
  - 地理统计图层
  - 不能直接支持**TIN;** 需要转换为栅格

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3D controls: 事件

- ISceneControlEvents/IGlobeControlEvents
  - OnDoubleClick
  - OnSceneReplaced /OnGlobeReplaced
  - OnKeyDown/Up
  - OnMouseDown/Move/Up
- ITOCBuddyEvents
  - ActiveViewChanged/Replaced

```
Private Sub AxGlobeControl1_OnGlobeReplaced(…) Handles AxGlobeControl1.OnGlobeReplaced
   Dim pglbbDispRend As IGlobeDisplayRendering
   pglbbDispRend = AxGlobeControl1.GlobeDisplay
   Dim bsun As Boolean
   bsun = pglbbDispRend.IsSunEnabled
   If bsun = True Then chkSun.Checked = True
   'Get the state of globetips from the loaded doc
   m_penumTips = AxGlobeControl1.GlobeViewer.GlobeDisplay.Globe.ShowGlobeTips
End Sub
```

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SceneGraph/GlobeDisplay 事件

- ISceneGraphEvents/IGlobeDisplayEvents
  - ActiveViewerChanged
  - AfterDraw/BeforeDraw
  - InteractionStopped
  - TileOverflow/VectorOverflow
  - ViewerAdded/ViewerRemoved

```
Public WithEvents m_pglbDisplay As GlobeDisplay
…
Private Sub m_pglbDisplay_AfterDraw(ByVal pViewer As ESRI.ArcGIS.Analyst3D.ISceneViewer)
   Handles m_pglbDisplay.AfterDraw
   If (chkStartStop.CheckState = CheckState.Checked) Then
       Dim globeDisplay As IGlobeDisplay
       globeDisplay = m_globe.GlobeDisplay
       If (Not globeDisplay.IsNavigating) Then
          ' Capture key frames after globe is done drawing
          Functions.CaptureKeyFrame(m_globe, m_animTrack)
          lstKeyFrames.Items.Add(m_animTrack.Keyframe(m_animTrack.KeyframeCount - 1).Name)
       End If
    End If
End Sub
```

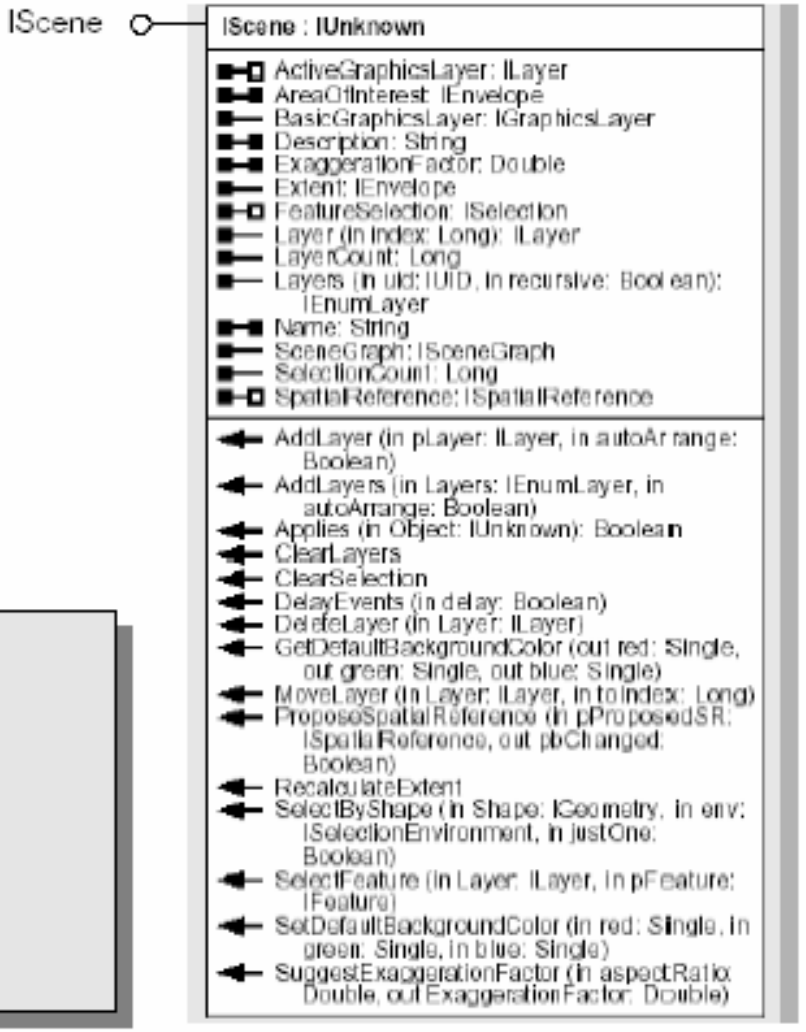
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SceneControl: Set the vertical exaggeration

- Access IScene
- Set exaggeration factor
  - IScene::ExaggerationFactor
- Should refresh the display

```
Private Sub trkVerticalExaggeration_Scroll(ByVal
    sender As System.Object, ByVal e As
    System.EventArgs) Handles
    trkVerticalExaggeration.Scroll

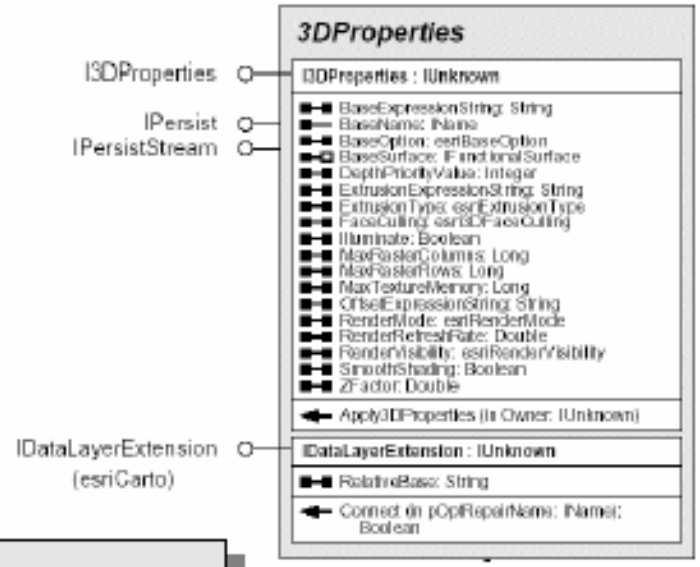
    trkVerticalExaggeration.Minimum = 1
    m_scene.ExaggerationFactor =
    trkVerticalExaggeration.Value
    AxSceneControl1.Refresh()
End Sub
```



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SceneControl: Draping raster over a surface

- Get a surface from TIN or raster
- Get the 3DProperties of the Layer
- Set TIN as base surface
  - I3DProperties::BaseSurface
- Invalidate the layer

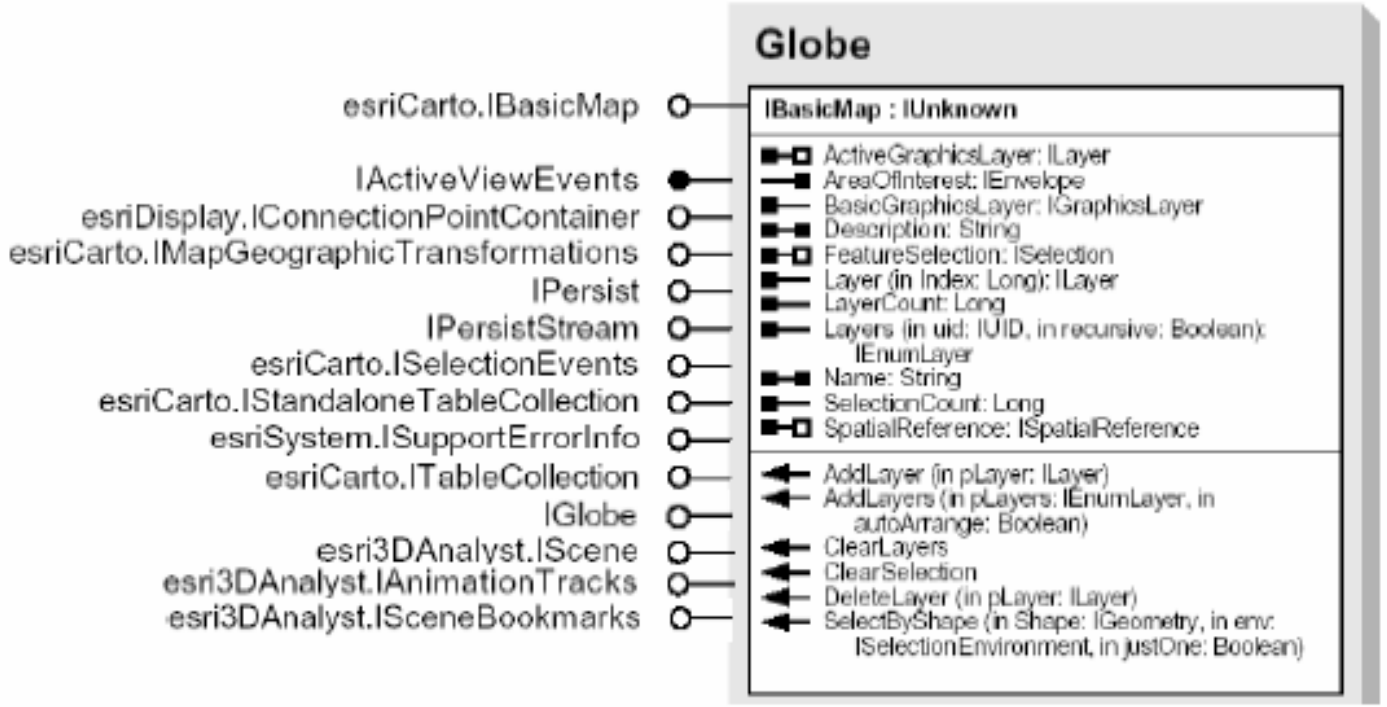



```
Dim pSurface As ISurface
Dim p3DProps As I3DProperties
Dim i As Integer
Dim pLayerExts As ILayerExtensions
pSurface = Functions.GetSurfaceFromTinLayer(…))
pLayerExts = layer
For i = 0 To pLayerExts.ExtensionCount - 1
    If TypeOf pLayerExts.Extension(i) Is I3DProperties Then
        p3DProps = pLayerExts.Extension(i)
    End If
Next
p3DProps.BaseSurface = pSurface
p3DProps.BaseOption = esriBaseOption.esriBaseSurface
m_scene.SceneGraph.Invalidate(layer, True, False)
AxSceneControl1.Refresh()
```

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The Globe CoClass

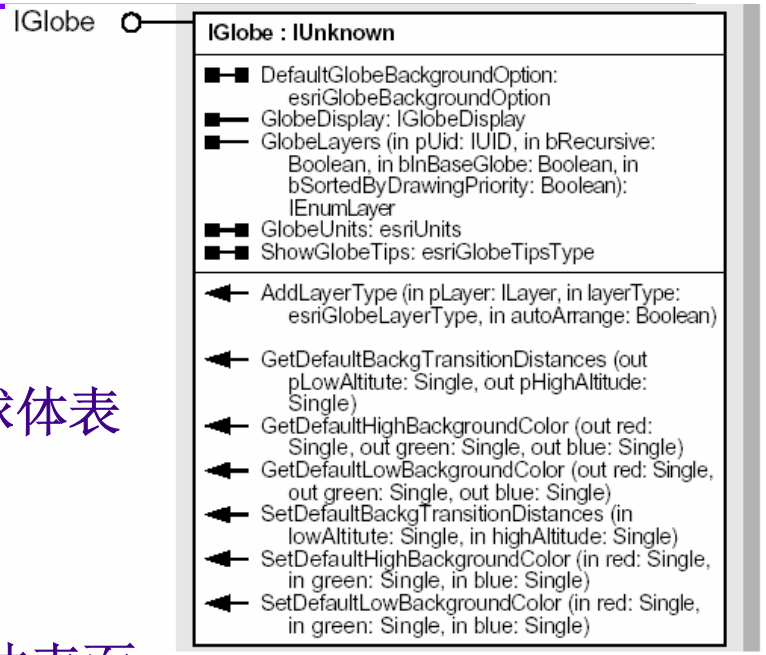
- Main coclass for the GlobeControl
- Container for 2D and 3D layers
- Similar to the Map in the MapControl



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使用 Globe图层

- **IGlobe**
  - **AddLayerType:** 多种图层类型
- 图层类型
  - 高程数据: 使用有高程的栅格数据来定义球体表面
  - 纹理数据: 覆盖在球体表面
  - 漂浮数据: 使用偏移来显示,高出或低于球体表面
- 也可以设置背景
  - 天空颜色, 空间颜色 , 颜色衰减 ...

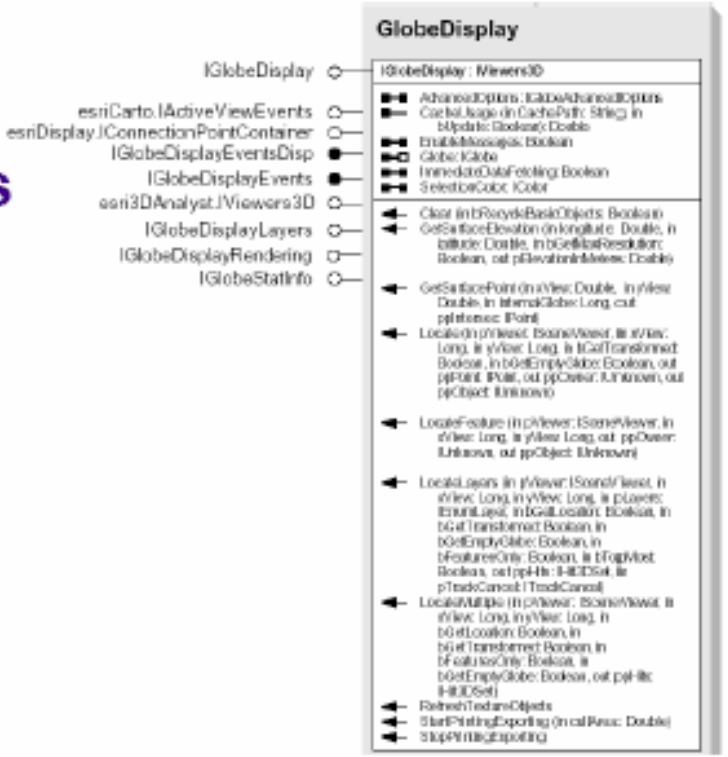


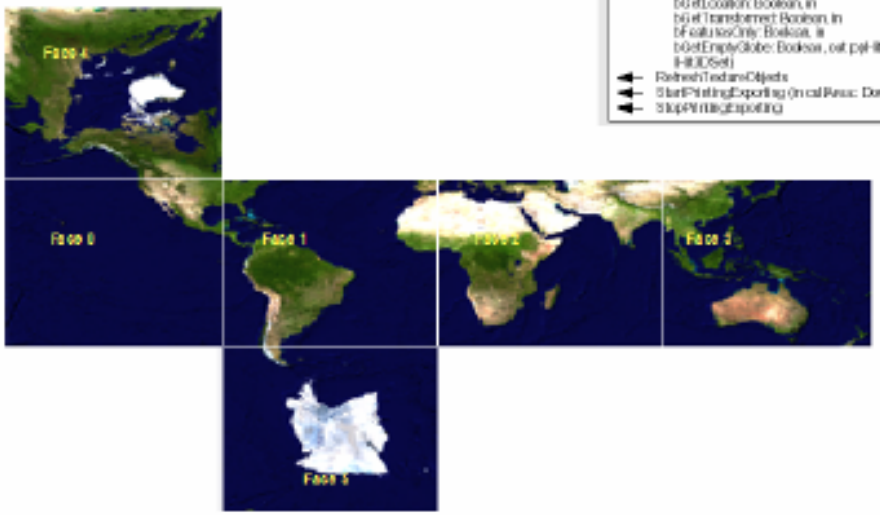


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The GlobeDisplay CoClass

- Central object in GlobeControl
- Divides the Globe into 6 face tiles
  - Four around the equator
  - Two at the poles
- Manages viewers, rendering and data caching
- On instance per process

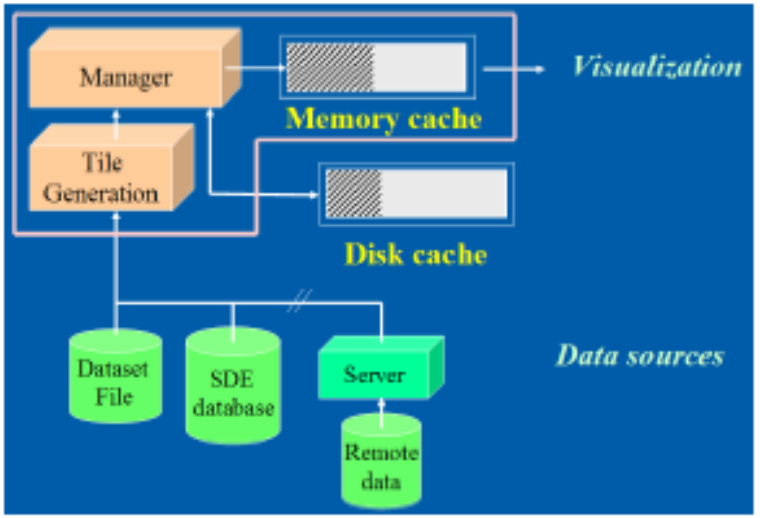




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*GlobeDisplay: Data caching

- Use to improve display and drawing performance
- Creates cache of tiles for each layer
- Tiles are stored
  - In the memory cache for immediate use
  - In the disk cache for later use



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Globe: 改变漂浮图层的偏移值

- 分配一个垂直高度,抬高或压低球体上的图层
- **IGlobeHeightProperties**
  - **BaseOption: esriGlobeLayerBaseSelf (初始图层高度)**
  - **Offset:** 高出或低于球体表面的高度

```
Private Sub TrackBar2_Scroll(ByVal sender As System.Object, ByVal e As System.EventArgs)
   Handles TrackBar2.Scroll
…
   While Not layer Is Nothing
      If layer.Name = "Countries" Then
         globeLayerProperties = globeDisplayLayers.FindGlobeProperties(layer)
         globeHeightProperties = globeLayerProperties.HeightProperties
         globeHeightProperties.BaseOption = esriGlobeLayerBaseOption.esriGlobeLayerBaseSelf
         globeHeightProperties.Offset = TrackBar2.Value * 500000
         globeHeightProperties.Apply(AxGlobeControl1.Globe, layer)
         AxGlobeControl1.GlobeDisplay.RefreshViewers()
      End If
      layer = enumlayer.Next
   End While
End Sub
```

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Globe: 记录和播放动画

- 四个基本步骤
  1. 创建或获取动画轨迹
  2. 捕捉关键帧
  3. 播放动画
  4. 保存和加载动画文件

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Globe: 查找已存在的动画轨迹

- 动画轨迹是关键帧的容器
- 你可以使用已经存在的动画轨迹
  - 访问已存关键帧
  - 增加/移除关键帧
  - 通过关键帧导航
- **IAnimationTracks**
  - **FindTrack: 字符串名称 (如 “Capture View”)**

```
Private Function GetTrackFromAnimationFile() As IAnimationTrack
   Dim animTracks As IAnimationTracks
   animTracks = m_globe
   Dim outAnimationTrack As IAnimationTrack
   animTracks.FindTrack("Capture View", outAnimationTrack)
   Return outAnimationTrack
End Function
```

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Globe: 创建新的动画轨迹

- 创建AnimationTrack 一个新实例
- 设置 AnimationType 和名称
- 从ActiveViewer获取摄影机并把它放在AnimationTrack 上
- 加载动画轨迹到AnimationTracks

```
'Create an animation track
Dim outAnimationTrack As IAnimationTrack
Dim camera As ICamera
Dim animType As IAnimationType
Dim animTracks As IAnimationTracks
animTracks = m_globe
outAnimationTrack = New AnimationTrack
animType = New AnimationTypeGlobeCamera
outAnimationTrack.AnimationType = animType
outAnimationTrack.Name = "Capture View“
camera = m_globe.GlobeDisplay.ActiveViewer.Camera
outAnimationTrack.AttachObject(camera)
outAnimationTrack.ApplyToAllViewers = True
animTracks.AddTrack(outAnimationTrack)
```

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Globe: 捕捉关键帧

- 关键帧即时记录了动画对象在一个特定位置的属性和行为
- **IKeyFrame::CaptureProperties:** 从一个对象拷贝属性 **(**如 **GlobeCamera)**

```
Public Shared Sub CaptureKeyFrame(ByVal pGlobe As IGlobe, ByVal
   pAnimTrack As IAnimationTrack)
   ' Get the GlobeCamera properties
   pCamera = pGlobe.GlobeDisplay.ActiveViewer.Camera
   pGlobeCamera = pCamera
   pGlobeCamera.OrientationMode =
   esriGlobeCameraOrientationMode.esriGlobeCameraOrientationLocal
   ' Create a New GlobeCamera Keyframe
   pKeyframe = New GlobeCameraKeyframe
   ' Assign GlobeCamera properties to Keyframe
   pKeyframe.CaptureProperties(pGlobe, pGlobeCamera)
   pKeyframe.Name = "Capture View" & pAnimTrack.KeyframeCount + 1
   ' Insert GlobeCamera Keyframe in Animation Track
   pAnimTrack.InsertKeyframe(pKeyframe, pAnimTrack.KeyframeCount + 1)
   pAnimTrack.EvenTimeStamps = True
   pAnimTrack.ResetTimeStamps()
End Sub
```

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Globe: 用事件捕捉关键帧

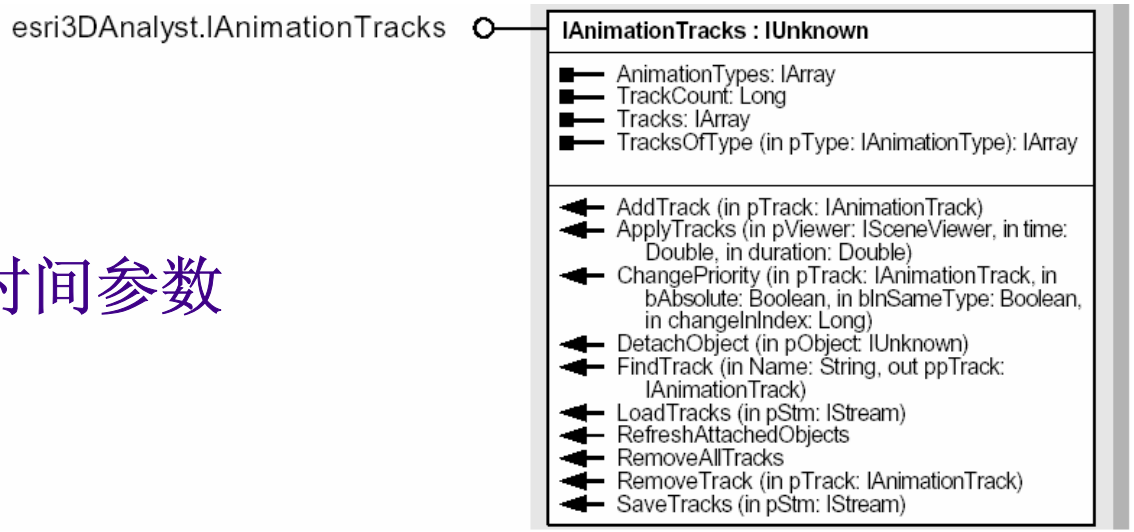
- 你可以使用绘制事件来捕捉关键帧
- 最小化捕获的帧数
  - 监听每个**IGlobeDisplay::AfterDraw** 事件
  - 只有当**globe**处于非导航模式时捕捉

```
Private Sub m_pglbDisplay_AfterDraw(ByVal pViewer As ESRI.ArcGIS.Analyst3D.ISceneViewer)
   Handles m_pglbDisplay.AfterDraw
   If (chkStartStop.CheckState = CheckState.Checked) Then
   Dim globeDisplay As IGlobeDisplay
   globeDisplay = m_globe.GlobeDisplay
     If (Not globeDisplay.IsNavigating) Then
       ' Capture key frames after globe is done drawing
       Functions.CaptureKeyFrame(m_globe, m_animTrack)
       lstKeyFrames.Items.Add(m_animTrack.Keyframe(m_animTrack.KeyframeCount - 1).Name)
     End If
   End If
End Sub
```

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Globe: 播放动画

- 应用轨迹到 3D 视图
- **IAnimationTracks**
  - **ApplyTracks**
- 传入共用时间和持续时间参数
  - 共用时间
  - 持续时间
- **IViewers3D**
  - **RefreshViewers**




```
st = DateTime.Now
Do
   et = DateTime.Now
   span = et.Subtract(st)
   elapsedTime = span.TotalSeconds
   If (elapsedTime > duration) Then
       elapsedTime = duration
   End If
   ptracks.ApplyTracks( Nothing, elapsedTime, duration)
   IpViewers3D.RefreshViewers()
Loop While elapsedTime < duration
```

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Globe: 保存和加载动画文件

- 容易保存和加载动画
- **IBasicScene**
  - **SaveAnimation:** 保存当前动画轨迹
  - **LoadAnimation:** 加载动画轨迹

```
Public Shared Sub SaveAnimation(ByRef globe As IGlobe, ByVal AnimationFile As String)
   Dim basicScene As IBasicScene
   basicScene = globe
   basicScene.SaveAnimation(AnimationFile)
End Sub

Public Shared Sub LoadAnimation(ByRef globe As IGlobe, ByVal AnimationFile As String)
   Dim basicScene As IBasicScene
   basicScene = globe
   Try
       basicScene.LoadAnimation(AnimationFile)
   Catch ex As Exception
       'If file doesn't exist, create it for the user...
       basicScene.SaveAnimation(AnimationFile)
       basicScene.LoadAnimation(AnimationFile)
   End Try
End Sub
```

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练习 4 概述

- 创建3D 控件应用程序
- 使用 3D 文档和数据源
- 控件成员的使用
- 在场景表面上添加栅格纹理
- 创建, 播放, 保存 Globe 动画

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课 4 回顾

- **SceneControl** 和 **GlobeControl**之间的主要区别在哪里?
- 加载数据到**3D**控件中的三种方法是什么?
- 什么是 **Globe** 的三种不同类型的图层?
- 哪种类型的 **Globe** 图层可以设置偏移?
- 加载关键帧到动画轨迹的命名方法?
- 在**Globe**中捕捉和播放动画的步骤有哪些?

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